MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2018/2019

DTC5088 – ANALOG AND DIGITAL COMMUNICATION SYSTEMS

(Diploma of Electronic Engineering)

28 MAY 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **4** pages excluding the cover page and **2** pages for appendices.

2. Answer **ALL** question.

3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Given $s_m(t) = 2\cos(40000\pi t)$,.. $s_c(t) = 4\cos(200000\pi t)$.Find:

i) the equation of a double sideband with suppressed carrier (DSB-SC).

[2 marks]

ii) upper-side band frequency, f_{usb} *and* lower-side band frequency, f_{lsb}.

[4 marks]

iii) the bandwidth of the modulated signal.

[2 marks]

iv) the modulation index and determine whether it is over-, ideal- or under-modulation.

[2 marks]

b) A Frequency Modulation (FM) modulator produces a modulated signal with peak deviation, $\delta = 45$ kHz, a modulating signal frequency, $f_m = 90$ kHz, carrier amplitude, $A_c = 10$ V and carrier frequency, $f_c = 5000$ kHz , determine the bandwidth without limitation of this signal.

[3 marks]

c) Figure 1 shows the frequency spectrum of a multi-tone signal for RF components. The receiver uses High Side Injection (HSI) and has Local Oscillator (LO) frequency, of 2000 kHz. Construct a frequency spectrum for the Intermediate Frequency (IF) components.

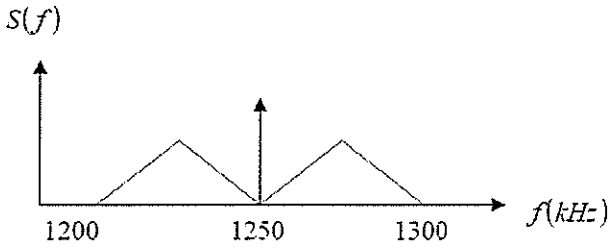

Figure 1

[8 marks]

d) Define the terms of selectivity and sensitivity of an Amplitude Modulation (AM) radio receiver.

[4 marks]

Continued...

QUESTION 2 [25 MARKS]

a) Name and explain all three stages involved in Pulse Code Modulation (PCM) process.

[9 marks]

b) Figure 2 shows the input signal, $g(t)$. Sketch the sampled signal when the input signal is sampled with a 5 kHz pulse train and have pulse width of $\tau = 10\,\mu s$ by using the following techniques:

i) Flat top sampling.

ii) Natural sampling.

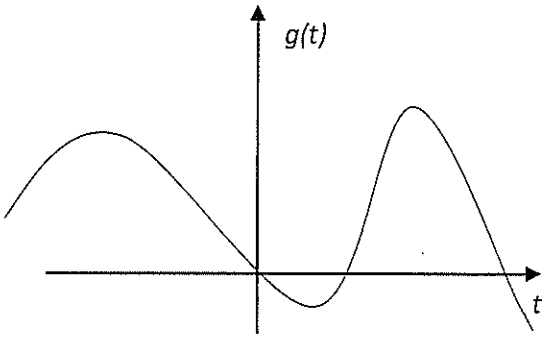

Figure 2

[6 marks]

c) An input signal having maximum frequency of 10 MHz is being quantized into 40 levels before it is encoded into Pulse Code Modulation (PCM). Determine:

i) number of bit used.

[2 marks]

ii) Coding efficiency.

[2 marks]

iii) Bit rate of the PCM signal produced.

[2 marks]

Continued...

d) Figure 3 shows the sampled input before it is being quantized. Determine the binary coded output after the data has been encoded.

[4 marks]

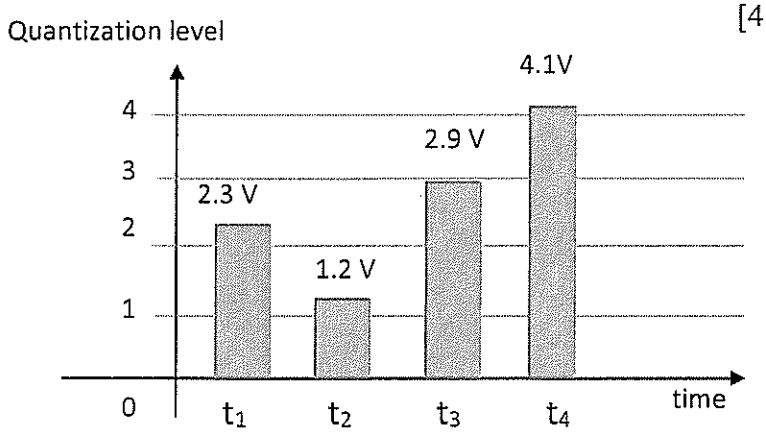

Figure 3

QUESTION 3 [25 MARKS]

a) Draw the modulated output for the data "01010" that have baud rate 5 baud/sec and bit rate of 5 bps using following modulation scheme:

i) ASK.

ii) FSK.

iii) 2-PSK.

[6 marks]

b) If the baud rate, N_{baud} of a quadrature amplitude modulation (QAM) signal is N_{baud} = 1000. What is the bandwidth for this QAM signal?

[2 marks]

c) PSK is one of the methods to modulate digital signal back into analog. Provide the phase to bit relationship table and sketch the constellation diagram for 8-PSK.

[4 marks]

d) Given a bandwidth of a transmission medium used is ranging from 1 kHz to 9 kHz. If the transmission is in ASK full-duplex mode, find the carrier frequencies in each direction. (Assume there is no gap between the bands in the two directions).

[5 marks]

e) What is the major disadvantage of using Non-Return to Zero (NRZ) encoding? How do Return-to-Zero (RZ) encoding and biphase encoding solve the problem?

[4 marks]

Continued...

f) Sketch the diagrams that can show the differences between Alternate Mark Inversion (AMI) and High-Density Bipolar 3 (HDB3) using the data of 10100001.

[4 marks]

QUESTION 4 [25 MARKS]

a) Define burst error and show one example of it.

[3 marks]

b) Construct a new data stream from the original data 01101010 using:

i) odd parity Vertical Redundancy Check (VRC)

[3 marks]

ii) Longitudinal Redundancy Check (LRC).

[3 marks]

c) Find the Cyclical Redundancy Check (CRC) for 100100 using the divisor of 1101.

[6 marks]

d) In a digital communication system that uses Hamming code, if the receiver received 10101010110 with a single bit error, show:

i) how the system detects the error?

[8 marks]

ii) which position the bit error occur?

[1 mark]

iii) the correct data.

[1 mark]

End of Page.

APPENDIX

(A) Amplitude Modulation

Carrier signal, $s_c(t) = A_c \cos(\omega_c t)$

Modulating signal, $s_m(t) = A_m \cos(\omega_m t)$

Amplitude-modulated signal,

DSB-LC: $s(t) = A_c \cos \omega_c t + \frac{A_m}{2}\cos(\omega_c - \omega_m)t + \frac{A_m}{2}\cos(\omega_c + \omega_m)t$

DSB-SC: $s(t) = \frac{A_m A_c}{2}\cos(\omega_c + \omega_m)t + \frac{A_m A_c}{2}\cos(\omega_c - \omega_m)t$

SSB-SC:

$$\text{LSB}: \quad s_{LSB}(t) = \frac{A_m A_c}{2}\cos(\omega_c t - \omega_m t)$$

$$\text{USB}: \quad s_{USB}(t) = \frac{A_m A_c}{2}\cos(\omega_c t + \omega_m t)$$

(B) Frequency Modulation

$$\phi_{FM} = A_c J_0(m_f)\sin \omega_c t +$$
$$A_c(J_1(m_f)(\sin(\omega_c + \omega_m)t - \sin(\omega_c - \omega_m)t)) +$$
$$A_c(J_2(m_f)(\sin(\omega_c + 2\omega_m)t - \sin(\omega_c - 2\omega_m)t)) +$$
$$A_c(J_3(m_f)(\sin(\omega_c + 3\omega_m)t - \sin(\omega_c - 3\omega_m)t)) +$$
$$A_c(J_4(m_f)(\sin(\omega_c + 4\omega_m)t - \sin(\omega_c - 4\omega_m)t)) +$$
$$A_c(J_5(m_f)(\sin(\omega_c + 5\omega_m)t - \sin(\omega_c - 5\omega_m)t)) + \ldots +$$
$$A_c(J_n(m_f)(\sin(\omega_c + n\omega_m)t - \sin(\omega_c - n\omega_m)t))$$

(C) AM Superheterodyne Receiver

Local oscillator frequency,

$f_{LO} = f_{RF(C)} + f_{IF(C)}$

$f_{LO} = f_{RF(USF)} + f_{IF(LSF)}$

$f_{LO} = f_{RF(LSF)} + f_{IF(USF)}$

(D) Hamming code

r1: bits 1, 3, 5, 7, 9, 11

r2: bits 2, 3, 6, 7, 10, 11

r4: bits 4, 5, 6, 7

r8: bits 8, 9, 10, 11

Bessel table function

Modulation Index (m_f)	Carrier Frequency J_0	n or order of sidebands														
		J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J_{15}	J_{16}
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—	—	—	—	—	—	—
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	—	—
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	—	—
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	—	—
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	—	—
6.0	0.15	−0.28	−0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	—	—
7.0	0.30	0.00	−0.30	−0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	—	—
8.0	0.17	0.23	−0.11	−0.29	−0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	—	—	—	—	—
9.0	−0.09	0.24	0.14	−0.18	−0.27	−0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03	0.01	—	—	—
10.0	−0.25	0.04	0.25	0.06	−0.22	−0.23	−0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.03	0.01	—	—
12.0	0.05	−0.22	−0.08	0.20	0.18	−0.07	−0.24	−0.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.03	0.01
15.0	−0.01	0.21	0.04	−0.19	−0.12	0.13	0.21	0.03	−0.17	−0.22	−0.09	0.10	0.24	0.28	0.25	0.18	0.12

Source: E. Cambi, *Bessel Functions*, Dover Publications, Inc., New York, N.Y., 1948. Courtesy of the publisher.